



Discharge-based QMRA for estimation of public health risks from exposure to stormwater-borne pathogens in recreational waters in the United States

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Year: 2013
Journal: Water Research. 47 (14): 5282-5297

Abstract:

This study is the first to report a quantitative microbial risk assessment (QMRA) on pathogens detected in stormwater discharges-of-concern, rather than relying on pathogen measurements in receiving waters. The pathogen concentrations include seven "Reference Pathogens" identified by the U.S. EPA: *Cryptosporidium*, *Giardia*, *Salmonella*, *Norovirus*, *Rotavirus*, *Enterovirus*, and *Adenovirus*. Data were collected from 12 sites representative of seven discharge types (including residential, commercial/industrial runoff, agricultural runoff, combined sewer overflows, and forested land), mainly during wet weather conditions during which times human health risks can be substantially elevated. The risks calculated herein therefore generally apply to short-term conditions (during and just after rainfall events) and so the results can be used by water managers to potentially inform the public, even for waters that comply with current criteria (based as they are on a 30-day mean risk). Using an example waterbody and mixed source, pathogen concentrations were used in QMRA models to generate risk profiles for primary and secondary water contact (or inhalation) by adults and children. A number of critical assumptions and considerations around the QMRA analysis are highlighted, particularly the harmonization of the pathogen concentrations measured in discharges during this project with those measured (using different methods) during the published dose-response clinical trials. *Norovirus* was the most dominant predicted health risk, though further research on its dose-response for illness (cf. infection) is needed. Even if the example mixed-source concentrations of pathogens had been reduced 30 times (by inactivation and mixing), the predicted swimming-associated illness rates - largely driven by *Norovirus* infections - can still be appreciable. *Rotavirus* generally induced the second-highest incidence of risk among the tested pathogens while risks for the other Reference Pathogens (*Giardia*, *Cryptosporidium*, *Adenovirus*, *Enterovirus* and *Salmonella*) were considerably lower. Secondary contact or inhalation resulted in considerable reductions in risk compared to primary contact. Measurements of *Norovirus* and careful incorporation of its concentrations into risk models (harmonization) should be a critical consideration for future QMRA efforts. The discharge-based QMRA approach presented herein is particularly relevant to cases where pathogens cannot be reliably detected in receiving waters with detection limits relevant to human health effects.

Source: <http://dx.doi.org/10.1016/j.watres.2013.06.001>

Resource Description

Exposure : ☐

weather or climate related pathway by which climate change affects health

Food/Water Quality

Food/Water Quality: Pathogen

Geographic Feature: 

resource focuses on specific type of geography

Freshwater

Geographic Location: 

resource focuses on specific location

United States

Health Impact: 

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Foodborne/Waterborne Disease

Foodborne/Waterborne Disease: Cryptosporidiosis, Giardiasis, Norovirus, Rotavirus, Salmonellosis

Foodborne/Waterborne Disease (other): Enterovirus; Adenovirus

Resource Type: 

format or standard characteristic of resource

Research Article

Timescale: 

time period studied

Time Scale Unspecified